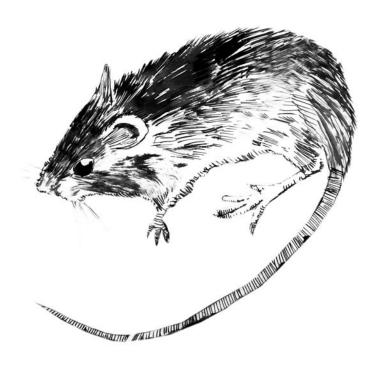
Rocky Flats National Wildlife Refuge

Resource Inventory



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Geology and Soils

The 6,240-acre Rocky Flats site is located at the interface of the Great Plains and Rocky Mountains, about 2 miles east of the foothill escarpment in Jefferson County, Colorado. Site elevation ranges from 5,500 feet in the southeastern corner to 6,200 feet near the current west entrance gate. The western half of site is characterized by the relatively flat Rocky Flats pediment, which gives way to several finger-like drainages that slope down to the rolling plains in the eastern portion of the site.

Surficial and Bedrock Geology

Geologic units at the Rocky Flats site range from unconsolidated surficial deposits to various bedrock layers (Figure 1). Surficial deposits in the western portions of the site are characterized by the Rocky Flats Alluvium, clayey and sandy gravels between 0 and 100 feet thick. The steeper slopes below the Rocky Flats Alluvium in the central portion of the site generally consist of landslide deposits. Surficial deposits in the eastern portion of the site consist of colluvium 3 to 15 feet thick and terrace alluvium 10 to 20 feet thick (Shroba and Carrara 1996).

The Rocky Flats Alluvium is underlain by the Arapahoe Formation, composed of sandstones, siltstones, and claystones that range from 0 to 50 feet thick. In several locations, springs emerge at the contact of the Rocky Flats Alluvium and the Arapahoe Formation. These springs support the tall upland shrubland community described in the *Vegetation Communities* section. Beneath the Arapahoe Formation lies the Laramie Formation, composed of 600 to 800 feet of silty to clayey sandstones, clayey siltstones, and claystones. The Laramie Formation is underlain by the Fox Hills Sandstone and Pierre Shale.

Geologic Hazards

Landslides and landslide deposits are common along the steep hillsides and incised drainages at the base of the Rocky Flats Alluvium escarpment. These deposits occur in areas where bedrock layers such as the Arapahoe Formation are capped by unconsolidated gravel formations such as the Rocky Flats Alluvium. While most of the landslide deposits are of Pleistocene origin, some, especially those in the Rock Creek drainage, are likely more recent. Many landslide areas have high swell potential, and are subject to sheet wash and soil creep (Shroba and Carrara 1996).

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Figure 1. Surficial Geology.

Seven geologic fault lines have been identified at Rocky Flats, including a northeast-trending reverse fault that extends across the western part of the Industrial Area. These faults are not believed to be a concern in regards to current or future human activities or facilities at the site (DOE 1997).

Mineral Resources

The Rocky Flats Alluvium is believed to be the only mineral resource feasible for development at the NWR. Historically, uranium, coal, oil and natural gas have been extracted near the Rocky Flats site. None of these mineral resources, however, appear to be feasible for development (DOE 1997). Mining rights and permits at the site are described in the *Infrastructure*, *Easements*, and *Utilities* section.

Soils

The soils at the site formed from alluvium (stream deposited), colluvium (gravity deposited), or residuum (exposed bedrock material). Soils in the western half of the site formed from alluvium, while those in the eastern half of the site formed from colluvium and residuum. Rocky Flats soils are shown in Figure 2.

Soils in the western half of the site are primarily the Flatirons and Nederland soils that formed in the Rocky Flats Alluvium. Flatirons soils consist of very cobbly to very stony loamy surfaces and clayey subsoils. These soils are deep and well drained. Flatirons soils are located on western pediment and ridgetops, as well as the upper portions of hillsides. Nederland soils have very cobbly loamy surfaces and subsoils. They are deep and well drained. Nederland soils are located on steeper hillsides and valley slopes in the western portion of Rocky Flats.

Soils in the eastern portion of the site consist primarily of Denver, Kutch, Midway, Valmont, Haverson, and Nunn soils. The Denver-Kutch-Midway complex consists of soils with loamy surfaces and clayey subsoils. The Denver soils are deep and well drained, the Kutch soils are moderately deep and well drained, while Midway soils are shallow and well drained. The Denver-Kutch-Midway complex is the dominant soil map unit in eastern portion of Rocky Flats, though it also occurs in western half along hillsides. Denver and Kutch soils are found on side slopes, and the Midway soils occur on steeper slopes. Valmont soils consist of deep, well-drained soils with loamy surfaces and loamy to clayey subsoils. This soil type is found in northeast corner of Rocky Flats on the eastward extension of the Rock Creek/Walnut Creek drainage divide. Haverson soils are loamy soils located in floodplains or low terraces. Nunn soils consist of deep, well-drained soils on lower slopes adjacent to drainage bottoms. They have loamy surfaces and loamy to clayey subsoils.

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Figure 2. Soils.

Soil Contamination

Elevated concentrations of plutonium and americium are currently found in the eastern portion of the site. Concentrations are highest on the eastern end of the Industrial Area, adjacent to the 903 Pad (DOE 1997). The 903 Pad is an area where industrial oil mixed with plutonium was stored in steel drums from 1958 to 1968. This mixture leaked onto the soils in the storage area, and these contaminated soils were subsequently blown by the wind and deposited to the east and southeast. In 1968, the storage area was capped with asphalt to prevent further release of contaminated soils. The contaminated area to the east of the 903 Pad is known as the 903 Lip Area. DOE plans to remediate the contaminated soils and retain jurisdiction over the area.

Water Resources

Surface Water

Three drainages originate on or near Rocky Flats: Rock Creek, Walnut Creek, and Woman Creek. Stream levels fluctuate depending on the season and amount of precipitation. Most streamflow is controlled by ground water discharge; streamflow is higher when ground water levels are higher, such as in the spring. Surface sheet flow is only a significant contributor to stream flows during high precipitation events (Kaiser-Hill 2002b). Water resources on Rocky Flats are shown on Figure 3.

Under current plans, no water will be imported to the Rocky Flats site once it is converted to a National Wildlife Refuge. Presently, the site purchases about 340 acre-feet/year of water from Denver Water. This water is stored in a raw water reservoir west of the Industrial Area, and then used for domestic purposes and in cooling towers. After use, domestic water is treated at the Wastewater Treatment Plant (WWTP) on the eastern edge of the Industrial Area, before it is released into pond B-3. From pond B-5, water is periodically released to Walnut Creek (Kaiser-Hill 2002b).

Rock Creek

The Rock Creek basin drains the northwest portion of the site. This drainage is characterized by relatively flat headwater areas to the west, and steep gullies and channels to the east where it cuts below the Rocky Flats Alluvium into bedrock formations. Rock Creek is hydrologically isolated from the rest of the site, and receives no water from the Industrial Area. Surface water generally originates from precipitation and shallow ground water discharge. Rock Creek continues off-site to the northeast, where it joins Coal Creek in the Boulder Creek basin (DOE 1997).

Figure 3. Water Resources.

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Walnut Creek

Walnut Creek consists of three tributaries that drain the central portion of the site, including most of the Industrial Area. The northernmost branch begins at the outfall of the East Landfill Pond. The central branch, North Walnut Creek, begins at the northern edge of the Industrial Area and flows through the "A" series ponds. South Walnut Creek begins within the Industrial Area and collects discharge from the Rocky Flats Wastewater Treatment Plant before flowing through the "B" series ponds. The three branches converge near the eastern Rocky Flats boundary before flowing off-site to the east.

Before 1992, Walnut Creek flowed into Great Western Reservoir and on to Big Dry Creek. The Broomfield Diversion Canal was constructed in 1992 to divert Walnut Creek water away from the reservoir. Walnut Creek is typically dry during most of the year.

During precipitation events, Walnut Creek flows typically do not increase due to high soil infiltration rates. Stream flows are dominated by pond releases. Typically, about one-third of the water released from the ponds goes into ground water. Terminal Pond A-4 releases about 51 acre-feet per event into North Walnut Creek and is discharged two to four times per year. Pond B-5 releases about 44 acre-feet per event into South Walnut Creek and is discharged six to eight times per year (Kaiser-Hill 2002b).

Woman Creek

The Woman Creek basin drains the southern portion of the Rocky Flats site. The Woman Creek drainage consists of two major branches that both begin off of the Rocky Flats site to the southwest. The main stem of Woman Creek flows across the site, passing to the south of the Industrial Area and flowing through the C-1 pond. The Mower Ditch diverts most of the flow into Mower Reservoir, east of Rocky Flats.

Similar to the Rock Creek drainage, the upper reaches of Woman Creek are characterized by shallow or indistinct channels. Alluvial soils along Woman Creek have high infiltration rates. The middle reaches of Woman Creek are more incised and have steeper gradients and side slopes. The eastern reaches of Woman Creek occupy a broad, gently sloping valley.

Typically, Woman Creek has no streamflow in late spring and summer. All surface flows are lost to ground water in the warmer months. In the winter, most of the baseflow is from Antelope Springs. Woman Creek is largely unaffected by pond releases (pond C-2 is discharged about once a year, with a release of 38 acre-feet). The average daily flow rate is 0.47 cfs.

Big Dry Creek

A small portion of Rocky Flats near its southern boundary lies within the Big Dry Creek drainage, though the creek itself does not flow onto the site. Big Dry Creek flows into Standley Lake about 1 mile east of Indiana Street.

Ditches

Besides the three principal drainages, several ditches cross the NWR. The South Interceptor Ditch currently collects runoff from the south of the Industrial Area, which channels surface runoff into the C-2 pond. The Smart Ditch originates at Rocky Flats Lake to the southwest of the site, enters Rocky Flats and flows through the South Woman Creek drainage for almost 2 miles before splitting off toward Standley Lake to the southeast. The Mower Ditch diverts most of Woman Creek toward Mower Reservoir to the east. The Upper Church Ditch enters Rocky Flats from the west, and traverses the Rock Creek/Walnut Creek drainage divide until it exits the site in the northeast corner. The McKay Ditch runs from the west side of the Industrial Area into the Walnut Creek drainage. The Kinnear Ditch diverts water from Coal Creek west of Rocky Flats and conveys it to the Woman Creek channel (Advanced Sciences 1991).

Pond water retention creates local wetland areas and creates artificial, intermittent flow downstream. The ponds were not lined when constructed, but do not appear to leak water to ground water due to thick layers of fine sediments that have accumulated in them (Kaiser-Hill 2002b).

Off-Site Surface Water

Standley Lake is a large water supply reservoir that serves nearby communities. It is located about 1 mile southeast of Rocky Flats on the main stem of Big Dry Creek. Upstream of Standley Lake just east of the Rocky Flats site, the Woman Creek Reservoir was constructed to intercept any Woman Creek flows that are not diverted through the Mower Ditch. This reservoir is intended to protect water quality in Standley Lake. The Mower Reservoir is located north of Woman Creek Reservoir on the east side of Indiana Street, and receives Woman Creek water through the Mower Ditch.

Immediately east of the site lies Great Western Reservoir, which is owned by the City and County of Broomfield and is used for irrigation. Rocky Flats Lake lies to the south and west of the site on land owned by the state. Rocky Flats Lake provides water for the Smart Ditch, which runs across the southern end of the site towards the D-2 pond, and eventually, Standley Lake.

Ground Water

Hydrogeology at the Rocky Flats site is characterized by three distinct units, the upper alluvial aquifer, lower aquitard, and the Laramie-Fox Hills aquifer. An aquifer is a geologic formation that has sufficient permeability to store and/or convey water. An aquitard is a confining layer with low permeability that can store large quantities of water but does not allow water to readily pass through it.

The upper alluvial aquifer is comprised of the unconsolidated materials that can be as much as 100 feet thick in the western portions of the site. The upper aquifer is generally recharged from precipitation or surface water bodies. Ground water in the unconsolidated alluvial aquifer is generally close to the land surface, with an average depth of 11 feet below ground surface.

Several springs have emerged in areas where the contact of the upper aquifer and the lower aquitard is exposed at the surface. While most of these springs occur within the Rock Creek drainage, Antelope Springs in the Woman Creek drainage has the largest discharge at Rocky Flats. Antelope Springs discharges continuously over several acres.

The lower aquitard is comprised of the deeper claystone and siltstone of the Laramie and Arapahoe Formations. These formations combined are up to 800 feet thick below Rocky Flats. Recharge of the lower aquitard occurs from downward flow through the upper aquifer, or directly through precipitation in areas where the bedrock is exposed. Beneath the aquitard lies the regional Laramie-Fox Hills aquifer. It is composed of the lower sandstone unit of the Laramie Formation and the Fox Hills Sandstone, and is confined by the overlying aquitard. Ground water levels in the bedrock aquifers are generally greater than 100 feet (DOE 1997).

Several portions of the upper alluvial aquifer east and northeast of the Industrial Area are known or suspected of being contaminated with radionuclides, volatile organic compounds, and metals. The aquitard is less contaminated than the upper alluvial aquifer. No contaminant plumes have been identified in the aquitard. The Laramie-Fox Hills aquifer beneath the site is unlikely to be contaminated (DOE 1997).

Future Hydrological Conditions

During site closure, the buildings, pavement and some of the subsurface utilities (to a depth of 3 feet) will be removed from the Industrial Area and the area will be re-graded. Subsurface utilities below 3 feet deep will be assessed individually and may be left in place. Landfill areas will be covered and also will be re-graded. These changes will affect the surface and ground water hydrology of the site. The following changes that would alter the hydrology of the Rocky Flats site are expected to occur (Kaiser-Hill 2002b):

- No more water will be imported to the site.
- Two channels in the Industrial Area will route water to the A- and B-series ponds.
- Treatment Plant discharge to pond B-3 will be discontinued.
- The upper reach of the South Interceptor Ditch will be removed.
- The Landfill Pond will be reduced in size.
- Subsurface drains in the Industrial Area will be removed down to 3 feet.
- Subsurface utilities will be removed and the area will be backfilled with Rocky Flats Alluvium, changing the hydraulic conductivity of the subsurface in the Industrial Area.
- Pavement and buildings will be removed in the Industrial Area (some basement slabs and walls will be left in place).
- The Industrial Area and landfill areas will be re-graded to match adjacent topography and the sites will be vegetated.
- Landfill areas will be covered and a slurry wall placed along the upgradient side of the Original Landfill.

These changes are expected to affect streamflow in Walnut and Woman creeks. Flow in Rock Creek will not be affected.

Walnut Creek

Changes will occur to Walnut Creek flows due to the elimination of wastewater treatment plant discharge to the creek, the removal of impervious areas in the Industrial Area, and the elimination of storm water drain discharges in the Industrial Area. Terminal pond (A-4 and B-5) discharges would decrease, and Walnut Creek flows will be dominated by pond discharge operations and any pond routing or structural modifications.

Ground water levels along the eastern portion of Walnut Creek will decrease due to reduced pond discharges. This would result in reduced baseflow within the creek. Rapid runoff from the Industrial Area would be eliminated due to removal of roofs and pavement. South Walnut Creek east of the Industrial Area is estimated to lose 90 percent of its annual flow. North Walnut Creek east of the Industrial Area is estimated to lose 65 percent of its annual flow. Only one release will occur annually from Terminal Pond A-4. The discharge of water off-site from Walnut Creek will decrease by 80 percent in wet years and 95 percent in dry years. Riparian and wetland areas located along eastern Walnut Creek and around the ponds would have a reduced water supply due to reductions in ground water levels, pond levels, frequency and volume of channel flow.

Woman Creek

Changes in the flow of Woman Creek would be insignificant, except for the area south of the Present Landfill where flows may decrease due to the possible use of covers and slurry walls at the landfill site. Drainage to the South Interceptor Ditch and baseflow within the ditch would

decrease because storm water flows from the Industrial Area will be significantly reduced. Changes in ditch flows, however, are not likely to affect Woman Creek flows because water from the ditch is detained in pond C-2 and the ditch supplies less than 10 percent of the flow of Woman Creek at the east boundary.

Vegetation Communities

A diverse mosaic of vegetation communities is found at the site. Two of these vegetation communities, the xeric tallgrass grassland and the tall upland shrubland, are considered to be rare in the region. Other significant vegetation communities include the riparian woodland, riparian shrubland, wetlands, mesic mixed grassland, xeric needle and thread grassland, reclaimed mixed grassland, and ponderosa pine woodland (Figure 4).

Table 1. Vegetation Communities at Rocky Flats.

Vegetation Community	Area (acres)	Vegetation Community	Area (acres)
Grasslands		Woodlands	
Xeric Tallgrass Grassland	1,568	Riparian Woodland	28
Mesic Mixed Grassland	2,199	Ponderosa Pine Woodland	9
Xeric Needle and Thread Grassland	187	Wetlands	
Reclaimed Mixed Grassland	640	Tall Marsh Wetland	31
Short Grassland	10	Short Marsh Wetland	121
Shrublands		Wet Meadow	254
Tall Upland Shrubland	34	Open Water/Mudflats	51
Riparian Shrubland	41	Other	
Other Shrubland	70	Disturbed and Developed Areas	997
Total			6,240

Grasslands

Xeric Tallgrass Grassland

This rare plant community is found on the rocky plains in the western portions of the site, extending eastward along several finger-like ridgelines. The xeric tallgrass grassland community covers 1,568 acres of the site. This plant community contains several different plant associations that include combinations of big bluestem, little bluestem, mountain muhly, sun sedge, Fendler's sandwort and Porter's aster. Other tallgrass prairie species include Indian-grass, prairie dropseed, switchgrass and needle-and-thread grass. It is found primarily in Flatirons and Nederland soils. This community is believed to be a relict once connected to the tallgrass prairie hundreds of miles to the east (Nelson 2003; Essington et al. 1996).

Figure 4. Vegetation.

The Colorado Natural Heritage Program (CNHP) has found that much of the xeric tallgrass prairies along the Colorado Front Range have been disturbed by urban and rural development over the last century. In addition, aggressive weed species such as cheat grass, Japanese brome, and diffuse knapweed have degraded many areas of this community throughout the region (Essington et al. 1996). The CNHP believes that the xeric tallgrass grassland community exists in fewer than 20 places globally, and that Rocky Flats has the largest example of this community remaining in Colorado, and perhaps North America. For this reason, the CNHP has given this community a G2/S2 rank, meaning that it is imperiled globally and within the state (Essington et al. 1996).

The xeric tallgrass prairie community is comprised of several sub-communities (Nelson 2003). One of these sub-communities was identified by ESCO during a five-year evaluation of bluestem-dominated grasslands in the Rocky Flats area. This study found that the major distinguishing feature of what ESCO calls the rare "Rocky Flats Bluestem Grassland" community is the simultaneous abundance of big bluestem, little bluestem, mountain muhly, and Porter's aster. While big and little bluestem are characteristic of Midwestern tallgrass prairies, mountain muhly and Porter's aster are characteristic of mountain environments. This unusual combination of mountain and plains grassland species in a consistent and recurring pattern across the Rocky Flats alluvial surface, along with evidence of exceptional stability makes this vegetation community a rare, if not unique resource (ESCO 2002).

At Rocky Flats, a Bluestem Grassland sub-community has been identified in sample plots in the upper Smart Ditch/South Woman Creek drainage and above the Rock Creek drainage near the border with the National Wind Technology Center (NWTC). All of these sites are within the larger xeric tallgrass grassland. The extent of this sub-community has not been mapped at the Rocky Flats site. ESCO believes the disappearance of Porter aster from some of the sample sites during the study is a result of herbicide spraying during on-going weed control efforts at Rocky Flats (ESCO 2002).

Threats to the xeric tallgrass grassland community include exotic weed species, such as diffuse knapweed, the absence of grazing and fire to regenerate the grasslands, and the possibility of mining the Rocky Flats Alluvium that supports the xeric tallgrass prairie (PTI 1997a; Nelson 2003). In its assessment of Rocky Flats bluestem grassland communities in the area, ESCO reported that restoring mined areas to support the presence of the dominant plant species appears to be feasible. However, ESCO also reported that the restoration of the full array of species and the ecological conditions that sustain them as a rare community (such as the soil mycorrhizae and

bacteria) is not technically feasible at this time and would require technical knowledge not presently available. To preserve the integrity of the xeric tallgrass grassland, ESCO recommended continued grazing (where appropriate) with reduced stocking rates alternating between summer and winter/spring (ESCO 2002).

Mesic Mixed Grassland

The mesic mixed grassland community is the largest vegetation community at Rocky Flats, covering 2,199 acres across the broad ridges, hillsides, and valley floors throughout the site and the rolling plains in the eastern portions of Rocky Flats (Figure 4). This community is characterized by western wheatgrass, blue grama, side-oats grama, prairie junegrass, Canada bluegrass, Kentucky bluegrass, green needlegrass, and little bluestem. This grassland occurs on clay loam soils having relatively higher soil moisture content than other upland areas resulting from subirrigation from the coarse alluvial soils, snow accumulation, and protection from wind (DOE 1997). It is very important to wildlife species including grassland birds, small mammals, and larger mammals such as mule deer.

The quality of mesic mixed grassland varies considerably across the site. In the western parts of the site, this community has been degraded by diffuse knapweed, while some areas in the eastern portion of the site have been degraded by weed species such as Japanese brome, alyssum, and musk thistle (PTI 1997a).

Xeric Needle and Thread Grassland

Several patches of xeric grassland dominated by needle-and-thread grass occur in the eastern half of Rocky Flats. These patches cover 187 acres. Other dominant grass species include New Mexico feathergrass, Canada bluegrass, Kentucky bluegrass, and Japanese brome (Nelson 2003). This grassland occurs primarily on the eastern extensions of the Rocky Flats pediment that is characterized by very cobbly sandy loam soils. Although not quite as cobbly, these soils are very similar to the soils that support the xeric tallgrass grassland community (Kaiser-Hill 1997). The largest expanse of needle-and-thread grassland at Rocky Flats occurs along the ridgetop north of the east access road.

Reclaimed Mixed Grassland

Reclaimed mixed grassland covers 640 acres of the site. These grasslands are located primarily in the southeastern portion of the site, in areas that were formerly cultivated for agriculture. Most of these areas have been re-seeded with a mixture of smooth brome and intermediate wheatgrass, both introduced species. Other common species include crested wheatgrass, sweetclover, and field bindweed (Kaiser-Hill 1997). Compared to the native grasslands at Rocky Flats, the

reclaimed grassland has little plant and animal diversity. Grassland birds such as the western meadowlark and vesper sparrow use this community (PTI 1997a).

Short Grassland

This grassland is typified by buffalo grass and blue grama, both short grass prairie species. Ten acres of this community are found on the site (Kaiser-Hill 1997).

Shrublands

Tall Upland Shrubland

Tall upland shrubland occurs on 34 acres of north-facing slopes above seeps and along streams, primarily within the Rock Creek drainage. The tall upland shrubland consists of a rare association of hawthorn, chokecherry, and occasionally wild plum. This shrubland is associated with ground water seeps that form at the contact of the Rocky Flats Alluvium and the underlying, relatively impermeable Arapahoe Formation. The herbaceous understory contains a number of species that are restricted to the cool, shaded microhabitat provided by the canopy. Understory species include Fendler waterleaf, spreading sweetroot, anise root, carrionflower greenbriar, fragile fern, Colorado violet, Rydberg's violet, and northern bedstraw. Although the tall upland shrubland represents less than one percent of the total area of Rocky Flats, it contains 55 percent of the vegetation species on the site (DOE/FWS 2001). This shrubland community is believed to be rare, and may not occur anywhere else (DOE/FWS 2001; Essington et al. 1996).

The tall upland shrubland community is threatened by exotic weeds that dominate the understory of the shrubland in some areas. Diffuse knapweed in particular may be invading portions of the shrubland where accumulated dead knapweed plants have buried the shrubs. In one location, this accumulation is over 7 feet deep (PTI 1997b). Because of its reliance on ground water seeps, preservation of the alluvial ground water flows is essential to sustain this community (PTI 1997b).

Riparian Shrubland

Riparian shrubland forms extensive, dense thickets of shrubs along the stream bottoms. This community covers 41 acres throughout the Rocky Flats site. It is dominated by coyote willow and leadplant with a herbaceous understory.

Other Shrubland

Other shrubland communities include short upland shrubland and savannah shrubland, covering 70 acres primarily in the Rock Creek drainage. Short upland shrubland is characterized by stands of snowberry and occasional Wood's rose, and is often found in association with wet meadows and other wetland or riparian communities. Savanna shrubland occurs in dryer areas

where scattered shrubs are interspersed with grasslands. Sumac is the predominant shrub in this community (Kaiser-Hill 1997).

Woodlands

Riparian Woodland

This riparian community is characterized by a diverse mixture of plains cottonwood, peach leaf willow, Siberian elm and coyote willow, with an understory of various shrubs such as leadplant and snowberry. Covering 28 acres, it is found primarily along the drainage bottoms of Rocky Flats, with the most significant stand occurring in the Rock Creek drainage (Kaiser-Hill 1997; PTI 1997a; Essington et al. 1996). The CNHP designates this community as the Great Plains riparian woodland complex.

The most significant threat to the riparian woodland community is from exotic weed species such as Canada thistle, musk thistle, smooth brome and Kentucky bluegrass. Preservation of this woodland community depends on the preservation of associated streamflow (PTI 1997a; Essington et al. 1996).

Ponderosa Pine Woodland

Isolated patches of ponderosa pine woodland cover 9 acres in the uppermost reaches of the Rock Creek and Woman Creek drainages near the western edge of the site. These scattered pines represent an eastward extension of the nearby foothills forests. While much of the understory is similar to the adjacent grassland communities, other associated plants are more likely to occur in foothills environments (DOE 1997).

Wetlands

Wetland communities cover 406 acres of the Rocky Flats site, and play an important role in sustaining the diverse vegetation and habitat types found on the site. The most significant wetland complexes at Rocky Flats are the seep-fed wetlands along the hillsides of the Rock Creek drainage, and the Antelope Springs complex in the Woman Creek drainage. These wetlands are significant because they have the largest contiguous areas, and the most complex plant associations (PTI 1997a).

Three wetland types, tall marsh, short marsh, and wet meadow, are found at the site. These wetland types occur in streamside areas along the valley floors, and near the seeps and springs that occur along many of the hillsides. Each wetland type is described below.

Tall Marsh Wetland

Tall marsh wetlands generally occur along ponds, ditches, and in persistently saturated seeps.

Covering 31 acres of the site, these wetlands are dominated by cattails, bulrushes, and associated

forbs such as watercress, showy milkweed, swamp milkweed and Canada thistle (a noxious weed). Antelope Springs in the Woman Creek drainage is the best example of a saturated slope wetland and tall marsh community at Rocky Flats.

Short Marsh Wetland

Covering 121 acres, this wetland type is commonly associated with seasonally inundated or saturated areas, such as hillside seeps. Prevalent species include Nebraska sedge, Baltic rush, and spike rush as well as forbs such as watercress and speedwell. Many hillside seeps also support the rare tall upland shrubland community.

Wet Meadow Wetland

These seasonally saturated wetlands occupy 254 acres on the perimeter of saturated wetlands and contain elements of both the short marsh wetland and upland mixed grassland communities. Prevalent species include redtop, prairie cordgrass, and solid stands of Canada bluegrass and western wheatgrass. Other key plants include common milkweed, wild iris, Canada thistle, dock and occasionally arnica (Nelson 2003).

Noxious Weeds

Noxious weeds are exotic, aggressive plants that invade native habitat and cause adverse economic or environmental impacts. Since 1990, the site has experienced a large increase in noxious weeds (DOE 1999). The noxious weed species at Rocky Flats with the greatest potential to degrade the native plant communities and are the most difficult to control include diffuse knapweed, musk thistle, dalmation toadlfax, Canada thistle, and St. Johnswort. Diffuse knapweed, an aggressive tumbleweed, is currently given highest control priority. Canada thistle is common in and around most of the wetlands, musk thistle is sparse but widespread across mesic grasslands, and dalmatian toadflax is common in xeric grasslands and other areas.

Prioritized noxious weed lists and selected weed control measures are found in the 2002 Annual Vegetation Management Plan. The three most abundant noxious weeds identified in 2001 mapping were: dalmatian toadflax infesting 2,504 acres; diffuse knapweed infesting 1,919 acres; and musk thistle infesting 869 acres (Table 2 and Figure 5) (Kaiser-Hill 2002a; DOE/FWS 2001).

Figure 5. Noxious Weeds.

Table 2. Major Noxious Weeds at Rocky Flats.

Weed Name	High Density (acres)	Medium Density (acres)	Low Density (acres)	Scattered Density (acres)	Total Infested Area (acres)
Dalmation toadflax	23	743	612	1,128	2,504
Diffuse knapweed	294	430	512	683	1,919
Musk thistle	129	131	247	362	869

DOE's Current Weed Management

Weed control measures currently used by DOE at Rocky Flats include biological controls (insects), physical or mechanical controls (grading and mowing), and chemical controls (herbicides). Biological controls are used in areas where other forms of weed control are impractical, such as riparian areas, and to complement other methods. Mechanical controls such as mowing are used along roadsides and near structures, while hand pulling and sickles are used to control some small weed infestations.

Chemical controls are used through much of the site to control persistent weed species. The 2002 Annual Vegetation Management Plan (Kaiser-Hill 2002a) prescribes spot herbicide applications for species such as scotch thistle and others. Larger areas that are dominated by diffuse knapweed, Russian knapweed, dalmatian toadflax, or musk thistle are controlled using aerial and ground application. About 48 acres were treated by ground application in 2002, while about 840 acres were treated by aerial herbicide application. Some of the more commonly used herbicides include Tordon 22K, Transline, Telar, and Roundup (Kaiser-Hill 2002a).

While aerial and broadcast herbicide application may encroach near Preble's meadow jumping mouse protection areas, Kaiser-Hill determined that there will be no adverse effect on the mouse (Kaiser-Hill 2002a). According to the Vegetation Management Plan, aerial herbicide application is restricted within 100 feet of riparian vegetation, and broadcast applications are restricted within 30 feet of Preble's mouse habitat. Drift cards are used to monitor wind-induced drift of herbicides near sensitive areas. Broadleaf herbicides to affect only target species and have no metabolic impact on wildlife have been selected. Therefore, even direct exposure of wildlife to the dilute compound would not risk mortality or solicit other adverse responses. The use of selective herbicides is expected to improve long-term habitat conditions for the mouse (Kaiser-Hill 2002a; Nelson 2003). Herbicides are approved for use and used by Kaiser-Hill Ecology Group staff in accordance with the 1999 Vegetation Management Environmental Assessment (DOE 1999), and Annual Vegetation Management Plans.

The use of prescribed burns and grazing on Rocky Flats grasslands was suggested by the Kaiser-Hill Ecology Group as a management tool to help control weeds, reduce plant litter, recycle nutrients, and improve the health and vigor of the native plant communities. Under current policies however, grazing is not permitted at Rocky Flats and all prescribed burns are "on hold" (Kaiser-Hill 2002a). In the 1999 Vegetation Management Environmental Assessment (EA), DOE found that intensively managed grazers may be effective in reducing weed populations in selected areas. However, it also explained that this tool would not be used because of the lack of staff and equipment that would be required to effectively implement grazing (DOE 1999). Prescribed burns are further described in the *Fire History and Manage*ment section.

Fire History and Management

Historical documentation indicates that the grasslands in the Rocky Flats area have been subjected to lightning and human-caused fires for thousands of years. These fires are believed to have played a major role in promoting native vegetation growth and diversity. Since 1972 wildfires have not been allowed to burn and only one controlled burn has been conducted in the grasslands at Rocky Flats. As a result, a fuel load of dead vegetation has been building up in the grasslands of Rocky Flats for at least 30 years. This buildup of dead vegetation has contributed to an invasion of noxious weeds on the site, particularly in the last 10 years (DOE 1999).

Seven wildfires have been documented on the site since 1993. In 1994, the Spring Grassland fire burned 70 acres between Highway 128 on the north boundary and the north access road. In 1996, the 104-acre Labor Day Grassland Fire burned much of an area penned in by access roads in the southern portion of the site. In February 2002, a 27-acre fire burned through portions of the Rock Creek drainage on the south side of Highway 128. As mentioned below, a 48-acre prescribed burn was conducted on April 6, 2000. The prescribed burn took place in the same area as the 1996 wildfire (Kaiser-Hill Ecology Group 2002).

Prescribed Burns

As outlined in the 1999 Vegetation Management EA, prescribed burns can be used to stimulate native vegetation growth and supplement other weed control efforts (DOE 1999). In 2000, a 48-acre test burn was conducted on the xeric tallgrass prairie south of the Industrial. While the burn is reported to have shown positive results (Kaiser-Hill 2002a), no additional prescribed burns have been conducted since 2000, and none are planned. The present rationale for not pursuing additional prescribed burns at Rocky Flats is that in the face of public outcry about the 2000 burn,

DOE prefers to wait until cleanup measures are completed and Service management plans are in place (Nelson 2003).

Wildlife

Many areas of the Rocky Flats site have remained relatively undisturbed for the last 30 to 50 years, allowing them to develop diverse habitat and associated wildlife. These wildlife communities are supported by the regional network of protected open space that surrounds the site on three sides, buffering wildlife habitat from the surrounding urban development.

Mammals

One of the most abundant and conspicuous mammal species at Rocky Flats is the mule deer. A resident herd of about 160 individuals inhabits the site. While mule deer concentrations vary by the season, they appear to have a general preference the following areas (shown in Figure 6):

- The open grasslands of the upper Rock Creek drainage
- The shrublands of the lower Rock Creek drainage
- The grasslands of the upper Walnut Creek drainage
- The hillsides above lower Walnut Creek
- Riparian bottomlands around Woman Creek and Antelope Springs
- The grasslands below the pediment in the Smart Ditch drainage¹

In the spring, mule deer exhibit an affinity for woody habitat, and secondarily for grasslands. In the summer, deer use is more generally divided among different habitats. In the fall, mule deer primarily use woody habitats, with grasslands also being important. In the winter, mule deer are commonly observed in grasslands and tall upland shrublands (Kaiser-Hill 2001).

Whitetail deer have become more common at the site, and are often observed in company with mule deer. American elk are known to visit Rocky Flats, but are not considered to be resident (DOE 1997).

Other mammals commonly observed at Rocky Flats include desert cottontail, muskrat, and porcupine. Muskrats generally occur in and around the ponds, while porcupine populations are limited to the shrubland and ponderosa pine habitats in the upper Rock Creek drainage. Blacktailed prairie dogs inhabit the Rocky Flats site in limited numbers (Figure 6), and are discussed below under *Federal Threatened Endangered and Candidate Species*. Numerous small mammal species, such as mice and voles, inhabit all vegetation community types at Rocky Flats. Preble's

 $^{^{1}}$ Based on seasonal surveys conducted by Kaiser-Hill Ecology Group staff between 1997 and 2001.

meadow jumping mouse, a threatened species, is described below under *Federal Threatened Endangered and Candidate Species*.

Two commonly observed carnivore species at Rocky Flats are the coyote, which occurs throughout the site, and raccoon, which is often seen in the Industrial Area and near watercourses. There are typically three to six coyote dens at Rocky Flats, supporting an estimated 14 to 16 individuals at any given time (Kaiser-Hill 2001).

Twenty-two coyote dens used between 1991 and 2002 have been identified at Rocky Flats. The coyote dens generally occur on hillsides near watercourses. Six dens were active in 2002. One active den was located in the upper Rock Creek drainage, two were located on the slopes above either side of Walnut Creek near Indiana Street, one was near the D-1 pond, one near Antelope Springs, and one in the upper South Woman Creek drainage (Nelson 2003).

Other carnivores include striped skunk, gray fox, red fox, long-tailed weasel, American badger and mink. Black bears and mountain lion tracks are occasionally observed at the site (Kaiser-Hill 2000; Kaiser-Hill 2001).

Birds

The most commonly observed raptors at Rocky Flats are red-tailed hawk, great horned owl, and American kestrel. Other less abundant raptors include Swainson's hawk, ferruginous hawk, prairie falcons, and long-eared owls. Most raptor species use riparian woodlands or tall upland shrublands for nesting and roosting habitat, and forage in all habitats at the site. Raptor nest sites observed between 1991 and 1998 are shown on Figure 6.

Over 185 species of migratory birds have been recorded at Rocky Flats, of which about 75 are believed to breed at the site. Of the estimated 100 neotropical migrants (migratory birds that breed north of the U.S./Mexico border and winter south of the border (PTI 1997a)) at Rocky Flats, about 45 are confirmed or suspected breeders at the site. Commonly observed bird species in wetland habitats include the red-winged blackbird, song sparrow, common yellowthroat, and common snipe. Common birds in riparian woodland areas include the northern oriole, American goldfinch, house finch, and yellow warbler. The tall upland shrubland habitat is inhabited by the song sparrow, rufus-sided towhee, black-billed magpie, yellow-breasted chat, and black-capped chickadee. Common grassland birds include the vesper sparrow, western meadowlark, grasshopper sparrow, and mourning dove (DOE 1997).

Figure 6. Wildlife Resources.

Several waterfowl species are found in the ponds at Rocky Flats. The most common waterfowl are mallards and Canada geese (DOE 1997). Great blue herons feed in mudflats and short marshlands, while double-crested cormorants are common summer residents.

The plains sharp-tailed grouse is extirpated from the area and is not known to occur at Rocky Flats (DOE 1997). However, the Rocky Flats site and surrounding areas contain potential habitat for the grouse. The City of Boulder Open Space and Mountain Parks Department, along with Boulder County Parks and Open Space and the Colorado Division of Wildlife (CDOW) have recently begun a sharp-tailed grouse reintroduction program on joint City-County owned open space land north of Rocky Flats. Wildlife officials transplanted five individuals in 2003. Additional grouse reintroductions are planned in the future (Brennan 2003).

Reptiles and Amphibians

In general, reptiles and amphibians are found in limited numbers at Rocky Flats due to an absence of suitable habitat. The most common reptiles are the bullsnake, yellow-bellied racer, Western plains garter snake, and prairie rattlesnake. All of these species occur in the open grassland habitats, although the garter snake typically lives close to water bodies. Other reptiles include the short-horned lizard in open grasslands, the eastern fence lizard in rocky shrublands, and the western painted turtle in ponds (DOE 1997).

The most abundant amphibian at Rocky Flats is the boreal chorus frog, which breeds in water bodies throughout the site. The northern leopard frog is less common, and is found only in permanent water bodies such as ponds (DOE 1997). The boreal chorus frog is relatively abundant in the streams and wetlands at Rocky Flats (Kaiser-Hill 2000). Other amphibians include the bullfrog, Woodhouse's toad, the plains spadefoot, and the tiger salamander (DOE 1997).

Aquatic Species

Aquatic species at Rocky Flats are limited by the low and irregular flows of most of the drainages and ditches. The most common aquatic macroinvertebrates are the larvae of the blackfly, midge, and mayfly (DOE 1997). Other species include caddisflies, craneflies, damselfly larvae, as well as snails and amphipods. Large macroinvertebrates such as crayfish and snails are potentially important prey for other fish, waterfowl and mammal species.

Each of the three primary drainages at Rocky Flats contain a variety of pond and stream habitats, varying amounts of habitat modification and seasonal water flows.

Fish habitat in Rock Creek is located in and around the Lindsay Ranch complex. In the Linday Ranch area, water flows are currently intermittent, and preclude the establishment of permanent fish populations. As part of the objectives of the Rock Creek Integrated Natural Resources Management Plan (2001), largemouth bass were removed from Lindsay Pond with rotenone in 2002. By August 2003, northern redbelly dace and possibly common shiner will be introduced to Lindsay Pond to establish a refugia for these declining Colorado native fish species.

The Walnut Creek drainage has been highly modified as part of the development of the Rocky Flats. The upper section of the drainage was filled, and the lower section modified into a series of small reservoirs that can retain water released from the industrial area. A variety of non-native fish species (rainbow trout, carp, bass) were introduced into the Walnut Creek reservoirs. Although all introductions did not establish reproducing fish populations, records indicate that carp, goldfish and fathead minnows are present within these reservoirs. Additional sampling of these reservoirs should be completed in 2003, as part of the program to restore the reservoirs.

Woman Creek retains a significant amount of stream habitat, and holds the majority of Rock Flats fish species. Native fish species known to maintain reproducing populations within Woman Creek include white suckers, fathead minnows, green sunfish, stonerollers and creek chubs. Two non-native fish species, golden shiners and largemouth bass, have also been reported in the drainage.

Wildlife Species of Special Concern

In addition to federally listed wildlife species described below in the *Federal Threatened*, *Endangered and Candidate Species* section, the Rocky Flats site has been known to support numerous species with special status designated by the U.S. Fish and Wildlife Service, the CDOW, or the CNHP because of their rare or imperiled status. These species are included in Table 3.

Table 3. Wildlife Species of Special Concern at Rocky Flats.

Common Name	Scientific Name	Status	Occurrence at Rocky Flats
Small-footed myotis	Myotis subulatus = M. ciliolabrum	Federal special concern	Observed Infrequently
Eastern short horned lizard	Phrynosoma douglassii brevirostra	Federal special concern	Known resident or regular visitor
Northern leopard frog	Rana pipiens	State special concern	Observed Infrequently
Northern goshawk	Accipiter gentilis	Federal special concern	Observed Infrequently
White-faced ibis	Plegadis chihi	Federal special concern	Known resident or regular visitor
Baird's sparrow	Ammodramus bairdii	Federal special concern	Observed Infrequently
Western burrowing owl	Athene cunicularia hypugea	Federal special concern, State threatened	Known resident or regular visitor
Ferruginous hawk	Buteo regalis	Federal/State special concern	Known resident or regular visitor
Black swift	Cypseliodes nige	Federal special concern	Observed Infrequently
Loggerhead shrike	Lanius ludovicianus	Federal special concern	Known resident or regular visitor
Long-billed curlew	Numenius americanus	State special concern	Observed Infrequently
Greater sandhill crane	Grus canadensis tibida	State threatened	Observed Infrequently
American white pelican	Pelecanus erythrorhynchos	State special concern	Observed Infrequently

Some of the species of special concern that are known residents or regular visitors to Rocky Flats are briefly described as follows. The eastern short horned lizard occupies grassland areas at Rocky Flats. The white-faced ibis are found in mudflats or grassy areas near open water. Western burrowing owl have been observed in grasslands. Ferruginous hawk and northern goshawk have been observed in riparian woodlands. Loggerhead shrike is suspected to breed in shrublands (PTI 1997a; DOE 1997).

Federal Threatened, Endangered and Candidate Species

Rocky Flats supports several wildlife species that are listed as threatened, endangered, or candidate species under the Endangered Species Act (ESA). Two federally listed wildlife species known to occur at the site are the Preble's meadow jumping mouse and the bald eagle. The black-tailed prairie dog is a candidate species.

Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse occurs in every major drainage on the site. Listed as a threatened species in 1998, the mouse occurs in habitat adjacent to streams and waterways along the Front Range of Colorado and southeastern Wyoming. At Rocky Flats, the mouse also has been found in wetlands and shrubland communities adjacent to the Rock Creek and Woman Creek drainages. The natural history and ecology of the Preble's is not well known, and an increase in knowledge about the species may change what is known about their habitat needs and associations.

In 2002, the U.S. Fish and Wildlife Service proposed critical habitat for the mouse throughout its range. The proposed critical habitat along the Colorado Front Range is defined as a variable distance from the edges of small streams (depending on stream order and size) (FWS 2002a). At Rocky Flats, the proposed critical habitat includes most of Rock Creek and its lower tributaries, the middle and south branches of Walnut Creek, the entire length of Woman Creek across the site, and the lower reaches of the South Woman Creek/Smart Ditch drainage. The proposed critical habitat will not likely include habitat in minor tributaries or associated with hillside seeps.

Preble's populations have also been found along Coal Creek on City of Boulder Open Space lands to the west and north of Rocky Flats (BOSMP 2002). Other populations are known to occur on Ralston Creek to the south-southwest of Rocky Flats.

Bald Eagle

The bald eagle occasionally forages at the site. No nests have been identified at Rocky Flats. The bald eagle was federally listed as endangered in 1967, and was downlisted to threatened in 1994. An active nest is located to the east of Rocky Flats near Standley Lake. Eagles feed primarily on fish and waterbirds but also on small mammals and mammal carcasses (DOE/FWS 2001).

Black-tailed Prairie Dog

The black-tailed prairie dog is a candidate for listing as a threatened species. Candidate species are plants and animals for which FWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Candidate species receive no statutory protection under the ESA (FWS 2002b).

Three black-tailed prairie dog colonies were mapped at Rocky Flats in 2000. A large colony is located near the eastern edge on the southwest side of the east entrance gate. One smaller colony

Figure 7. Potential Prairie Dog Habitat

exists along the northern border along Highway 128, and another along the southern border near Big Dry Creek. These colonies are shown on Figures 6 and 7.

The Rocky Flats site contains about 2,460 acres of potential prairie dog habitat (Figure 7). Prairie dogs are known to prefer the following habitat attributes (Clippinger 1989):

- 30 to 90 percent herbaceous cover
- 2- to 10-inch vegetation height
- Slopes less than 20 percent (prefer less than 10 percent)
- Rock-free soils with less than 70 percent sand content

The potential prairie dog habitat shown in Figure 7 is based on soils, vegetation, and slope. It should be noted that prairie dogs have been known to occur in other areas of the site, where habitat conditions are marginal due to stony soils or tallgrass grasslands. However, over the long term, prairie dogs at Rocky Flats are most likely to successfully colonize those areas that provide preferable habitat conditions, as shown in Figure 7.

The xeric tallgrass prairie community at Rocky Flats is not considered to be prairie dog habitat primarily because the vegetation height impacts their need for open vistas. In addition, the warm season grasses that dominate the tallgrass prairie do not maintain their nutritive value in dormancy. Because prairie dogs do not migrate seasonally, the tallgrass prairie may be unable to sustain prairie dog populations through the winter (City of Boulder 1996).

Plant Species

No federally listed plant species are known to occur at Rocky Flats. While many of the riparian and wetland communities support potential habitat for the Ute ladies'-tresses orchid and Colorado butterfly plant, these species are not known to occur at the site (ESCO 1994). The mosaic of vegetation communities at Rocky Flats contains several rare and sensitive plant communities. These include the xeric tallgrass grassland, tall upland shrubland, riparian shrubland, and plains cottonwood riparian woodland communities. Each of these communities is described in detail in the *Vegetation* section.

Cultural and Historical Resources

Cultural resource surveys have identified and recorded 45 cultural or historical sites or artifacts at the Rocky Flats site. Most of these sites or artifacts are related to Euro-American occupation of the area within the last 120 years. None of the identified cultural resources are recommended as eligible for listing on the National Register of Historic Places.

Prehistoric Resources

While it is apparent that various Native American groups occupied the Rocky Flats region prior to 1800, there are few material remains from this period on the site. Cultural resource inventories have identified several isolated finds of prehistoric origin, including stone enclosures and stone cairns. Two rectangular stone enclosures dating from the Early Ceramic period (AD 1-1000) were located at the Lindsay Ranch site in 1971. In addition a projectile point of Early Ceramic affiliation, a piece of ground stone and chipped stone have been recorded (Dames & Moore 1991).

Historic Resources

Numerous sites and artifacts related to agricultural and mining activity at Rocky Flats in the early 20th century have been identified. These sites include ditches, stock ponds, rock piles, building remains, fencing materials, and other farming and ranching-related equipment (Figure 8). An abandoned railroad grade, whose construction began in 1881 and was never completed, traverses the upper tributaries of Rock Creek in the northwestern corner of the site.

While there are few historic sites at Rocky Flats reflecting Native American occupation or Euro-American activities prior to 1900, there are many sites related to the land uses at Rocky Flats during the early 20th century. During this time, the cattle industry along the Front Range boomed, and several families began to acquire land for pasture in the Rocky Flats area. In most cases, the primary ranch sites were located outside of what became the Rocky Flats site, with the exception of the Lindsay Ranch (Dames & Moore 1991).

Lindsay Ranch

The area that is known as the Lindsay Ranch was originally homesteaded by the Scott family in 1868. The northern part of the Lindsay Ranch area was given to the railroad in 1897 as part of the railroad land grants. Other lands surrounding what became the Lindsay Ranch were homesteaded by various settlers in the 1880s and 1890s. Between the late 1880s and 1916, the Jones family, one of the original homesteaders in the area, had acquired the area that would become the Lindsay Ranch. During this time, many of the original homesteads were being consolidated into larger parcels to provide pasture for cattle.

Figure 8. Cultural Resources.

In 1916, almost 700 acres of land in the area was sold to the Ebertarter family, who controlled 1,280 acres along the northern portion of the current Rocky Flats site. The land was sold to G. Lindsay in 1941. Ten years later, the U.S. Atomic Energy Commission purchased the Lindsay Ranch for the creation of Rocky Flats (Dames & Moore 1991).

Cold War Era

The Rocky Flats site was one of the 13 nuclear weapons production facilities in the United States during the Cold War. Weapons production ended in 1989. The DOE completed a inventory of all buildings on the site and determined 64 facilities within the Industrial Area are very important to regional, national, and international history for their role during the Cold War era. The State Historic Preservation Office has determined that these 64 facilities are eligible for the National Register of Historic Places as a historic district (DOE 1997). All of these facilities will be removed before site closure.

Infrastructure, Easements, and Utilities

Transportation

The Rocky Flats site is surrounded on all sides by State highways and a major thoroughfare. Colorado State Highway (SH) 128 defines most of the site's northern boundary, while SH 93 runs parallel to the western boundary about ¼ mile to the west. Less than 1 mile to the south, SH 72 runs parallel to the site's southern boundary. Indiana Street defines the site's eastern boundary. Indiana Street currently has a right-of-way width of 50 feet. Access to the site is from SH 93 or Indiana Street. Outside of the Industrial Area, which currently contains a network of paved streets, most of the site is accessed by a network of graded gravel roads and minor two-track roads (Figure 9).

The Rocky Flats site currently has many roads, fences and utilities that serve its pre-closure functions. In addition, there are existing mineral rights and water rights on site that are owned by outside entities. Existing infrastructure, utility easements, and mining permits are shown on Figure 9.

Utilities

The utility infrastructure currently serving the site, including electric, natural gas, and sewer lines, will be removed or remediated in place prior to closure. According to the Rocky Flats National Wildlife Refuge Act, existing, privately-owned utility easements across the site will remain in place, and the owners of those easements will have the right to continue to access their property.

Figure 9. Infrastructure, Easements and Utilities.

Natural Gas Easements

Two natural gas easements are currently on the site, a north-south easement and an east-west easement. The north-south easement runs through the eastern portion of the site. The east-west easement runs along the southern edge of the Industrial Area, extending between the east and west access gates (Figure 9). In an area east and south of the Industrial Area, the title to portions of both natural gas easements is unclear (Schiesswohl 2003).

Electrical Line Easements

A 230-kV electrical line follows an easement through the southern and eastern portions of the site. The line runs in a north-south orientation between the north boundary and the proximity of South Woman Creek, where it then runs southwesterly towards the southern boundary of Rocky Flats. A second electrical line easement runs from the proximity of the C-2 pond to the east gate along Indiana Street.

Two parallel 115-kV electrical lines follow easements from the northeast corner of Rocky Flats towards the Industrial Area. These lines were constructed primarily to serve the Rocky Flats Industrial Area, and will be removed and easements abandoned prior to site closure. Another electrical line easement follows the west access road from Highway 93 to the Industrial Area. This electrical line has been removed, and the easement will be abandoned (the title to this easement is unclear). These easements are shown on Figure 9. An electrical line with no easement follows the west side of Indiana Street, within the Rocky Flats boundary.

Other Utilities

A fiber optic line with an easement runs from the NWTC in the northwest corner of the site, across the Rock Creek drainage, to the Industrial Area. The future of this line and easement is uncertain. In addition to the electrical line along the west side of Indiana Street, a telephone and fiber optic line also follows the Indiana right-of-way. These utility lines do not have easements, and may be located within the Rocky Flats site (instead of the Indiana right-of-way) (Schiesswohl 2003).

Mineral Rights

The U.S. Government does not own all of the subsurface mineral rights at the Rocky Flats site. As shown in Figure 9, there are currently two permitted mining areas at Rocky Flats:

- Bluestone Sand and Gravel mine 425 acres
- Lakewood Brick and Tile 80 acres

LaFarge, Inc. (formerly Western Aggregates) operates the Bluestone sand and gravel quarry in the northwestern corner of the site. While the permit boundary includes 425 acres of land, about 300 of those acres are designated for habitat preservation, or non-mining setback, easements and buffer areas (Jefferson County 2002). The Bluestone permit allows expansion of the mine into the northern portion of the Rock Creek drainage, near the NWTC (Figure 9). Most of the Rock Creek drainage is included in a habitat preservation area.

Lakewood Brick and Tile operates the 80-acre clay mining area immediately north of the west access road. On the east side of the Lakewood Brick and Tile pit, a mining permit for the Church Pit was preliminarily approved by the state in 1987. However, the permit for the Church Pit has not been completed (Schiesswohl 2003; Mount 2003).

Water Rights

As discussed in the *Water Resources* section, the current water supply to the Rocky Flats site will be terminated following the cleanup and closure of the existing facilities. There are currently no plans for a new water supply to serve the Rocky Flats NWR. The U.S. Government does not own water rights on the Rocky Flats site. However, two outside entities do own water rights. The Smart Ditch and Irrigation Company owns water rights through the Smart Ditch from Rocky Flats Lake (west of the site) to the D-2 Pond in the southeast corner. The City and County of Broomfield owns water rights in the Upper Church Ditch and the McKay Ditch, which convey water across the site to the east and northeast. Other water rights on the site include the Mower Ditch and the Kinnear Ditch (Advanced Sciences 1991).

Surrounding Land Use

The Rocky Flats site is located at the intersection of Jefferson, Boulder, and Broomfield counties. The site is surrounded by open space to the north, east, and west, and urban development to the northeast and southeast (Figure 10). Other nearby land uses include mining operations, wind energy research, and water collection and storage facilities.

Municipalities

Four principal cities and towns, Arvada, Westminster, Broomfield, and Superior, are located within close proximity of Rocky Flats. The general land uses of those portions of these municipalities located near the site are described below.

The City of Arvada is located southeast of Rocky Flats. While most of Arvada's residential and commercial development is located over 1 mile from Rocky Flats, the City's incorporated boundary directly abuts the site. A large area immediately south of Rocky Flats and east of

Highway 93 has been annexed by the City, and is planned for residential and mixed development. This area, known as the Vauxmont property, is currently vacant and used for livestock grazing.

North of Arvada, the City of Westminster is located directly east of Rocky Flats. However, most of the western portions of Westminster's incorporated area consist of open space. Residential land uses begin about 1.5 miles east of Rocky Flats.

The City and County of Broomfield is located immediately east and northeast of Rocky Flats. The area to the east is dominated by open space associated with Great Western Reservoir and vacant land. Other portions of this area are planned for development supporting office complexes. An existing office complex is located about 1 mile northeast of Rocky Flats on the north side of Highway 128.

The Town of Superior is located to the north and northeast of Rocky Flats' northeastern corner. Existing residential land uses are located about ¼ mile to the north of Rocky Flats, while future residential developments are proposed for the area. Superior's town center is located about 2 miles north of the Rocky Flats boundary.

Woman Creek Reservoir Authority

The Woman Creek Reservoir Authority is a separate unit of government comprised of the cities of Westminster, Thornton, and Northglenn. The Authority constructed the Woman Creek Reservoir in 1996 to prevent the flow of surface water from Rocky Flats into Standley Lake, a drinking water source for several communities (CDPHE 2003). The Woman Creek Reservoir Authority owns the reservoir and some of the land surrounding the reservoir.

Open Space

The Rocky Flats site is surrounded on three sides by designated open space. These open space lands are owned and managed by seven different jurisdictions. These areas are described in detail in the *Open Space, Recreation and Trails* section.

Other Nearby Land Uses

The Colorado State Land Board manages state land in Section 16 immediately adjacent to Rocky Flats to the southwest. Portions of Section 16 have been mined for clay and aggregates, while most of the land is leased for grazing livestock.

The Department of Energy's National Renewable Energy Laboratory operates the National Wind Technology Center immediately adjacent to Rocky Flats to the northwest. This facility is used for research on power-generating wind turbines.

Denver Water owns a large tract of land about 1 mile to the southwest of Rocky Flats along the west side of Highway 93 from Highway 72 south to Ralston Reservoir. While portions of this land are used for water collection and distribution facilities, most of it is undeveloped. This property includes a potential reservoir site in Leyden Gulch (Bassett 2002).

Two companies, TXI and LaFarge, operate gravel mining and processing facilities on two separate but contiguous sites in the northwest corner of Rocky Flats site and on adjacent privately-owned land. The mining facilities consist of surface excavations, material conveyors, rail lines, and processing facilities (DOE-NREL 2002).

Jefferson County Airport is located about 2 miles east of Rocky Flats. Airport runways are aligned in a northeast/southwest configuration. Aircraft takeoff and landing patterns currently do not pass directly over the Rocky Flats site (DOE-NREL 2002).

Open Space, Recreation and Trails

Rocky Flats is surrounded on three sides by designated open space. While some of these open space parcels restrict public use, others provide a network of recreational trails that are connected to the surrounding communities (Figure 10).

City of Boulder Open Space and Mountain Parks

The City of Boulder Open Space and Mountain Parks (BOSMP) owns and manages several large open space parcels near the northern and western edges of Rocky Flats. BOSMP lands along the northern edge of Rocky Flats extend from near the middle of Rocky Flats to the west along the Boulder/Jefferson county line for over 4 miles to the top of Eldorado Mountain. These lands are collectively referred to as South Boulder Open Space. Within Jefferson County, BOSMP also owns the Jewell Mountain and Van Fleet properties to the west of Rocky Flats between Highway 93 and Coal Creek.

BOSMP lands offer a network of soft-surface trails available for hiking, mountain biking, and equestrian use. The Flatirons Vista and Greenbelt Plateau trailheads are located about 1 mile from Rocky Flats to the northwest near the Highway 93/128 intersection.

Most BOSMP lands near Rocky Flats permit livestock grazing. The Jewell Mountain Property to the west of Rocky Flats and other properties along Coal Creek are grazed during the summer (BOSMP 2002).

BOSMP is working with several other organizations to protect and restore the Coal Creek riparian area that runs through their properties near Rocky Flats. Restoration activities include fencing to

Figure 10. Regional Open Space and Trails.

control livestock, stream channel restoration, wetland restoration, and monitoring. Small mammal trapping along Coal Creek has revealed several occurrences of Preble's meadow jumping mouse (BOSMP 2002).

Boulder County Open Space

Boulder County owns several open space parcels on the north side of Rocky Flats between the Town of Superior to the east and BOSMP lands to the west. These holdings include the Lindsay, Zacharias/Thomas, and Carlson/Lastoka properties. Recreational access to Boulder County Open Space lands to the north and northeast of Rocky Flats is from the Coalton Trail, which begins on Highway 128 north of Rocky Flats. This trail joins the Rock Creek Trail in the Town of Superior.

Jefferson County Open Space

Jefferson County owns and manages several parcels to the west and southwest of Rocky Flats. The Ranson-Edwards property immediately west of Rocky Flats extends from Coal Creek to the west. Coal Creek Canyon Open Space is located along the south side of Highway 72 about 2 miles west of Rocky Flats. Jefferson County also owns several conservation easements in this area. White Ranch Open Space is located about 3 miles to the southwest of the site.

The 2,807-acre Coal Creek Canyon Park currently has no developed trails or facilities. The park is divided into three management unit designations. The Parkland Recreation Area is intended for a trailhead and other facilities along Highway 72. The Natural Area management unit comprises most of the park area and includes an area of xeric tallgrass prairie. This area also will be managed for natural surface trail opportunities. The Sensitive Area along Coal Creek contains a population of Preble's meadow jumping mouse, whose suitable habitat extends west into Coal Creek Canyon. Due to uncertainties surrounding the future management of other publicly owned properties in the immediate area, including Rocky Flats and Denver Water properties, the Management Plan for this property recommends postponing any trail or facility development for 5 to 7 years (JCOS 2001).

Eldorado Canyon State Park

Eldorado Canyon State Park is located about 2 miles northwest of Rocky Flats, where South Boulder Creek bisects the Front Range. The park offers world-class rock climbing, picnic facilities and several soft-surface trails available for hiking, mountain biking, and equestrian use.

City of Arvada Open Space

The City of Arvada owns several open space parcels about 2 miles south of Rocky Flats. These parcels are located around Arvada Reservoir, along Leyden Gulch, and in the area between the

two. A network of paved and unpaved trails run throughout the City of Arvada, including the unpaved Leyden Gulch trail located about 1.5 miles south of Rocky Flats.

City of Westminster Open Space

The City of Westminster has several open space properties to the east and southeast of Rocky Flats. These properties include the Colorado Hills Open Space and Standley Lake Regional Park. Colorado Hills includes a soft-surface trail between Mower Reservoir and adjacent residential areas. Standley Lake is a regional destination for boating, swimming and picnicking. This park is also a focal point for Arvada and Westminster's paved greenway trail systems.

City and County of Broomfield Open Space

Directly east of Rocky Flats, Broomfield owns the Great Western Open Space lands surrounding its Great Western Reservoir. This area consists mainly of former grazed or cultivated fields. The City and County of Broomfield considers Great Western Open Space to be a highly suitable receiving site for prairie dog relocation. The establishment of a large prairie dog town at Great Western Reservoir Open Space would likely attract a greater number of raptors and other predators to the area, and may encourage the expansion of prairie dogs in the eastern portions of the Rocky Flats NWR (City and County of Broomfield 2001).

Town of Superior Open Space

Superior's open space is located across Highway 128 at the northeast corner of Rocky Flats, on the east side of McCaslin Boulevard. A network of paved trails throughout Superior's residential neighborhoods connects to the Rock Creek Trail, which continues to the northeast into Broomfield.

Proposed Trails and Open Space Facilities

City of Arvada

The City of Arvada Trails Master Plan has identified several potential trail corridors in the Rocky Flats area (Arvada 2001). The proposed Big Dry Creek Trail would follow the creek from Standley Lake west toward Highway 93, directly abutting the Rocky Flats site at one location. On the south side of Highway 72, the proposed Barbara Gulch Trail would connect the City of Arvada to the Highway 72/93 intersection.

Denver Water

A new off-channel water storage reservoir is proposed for the Leyden Reservoir site to the southwest of the Highway 93/72 intersection. If implemented, Denver Water land surrounding the reservoir will be managed by the City of Arvada as open space (Bassett 2002).

Front Range Trail

The Front Range Trail planning project identified a potential north/south trail corridor along the east side of Highway 93, between the highway and the Rocky Flats boundary.

Town of Superior

The Town of Superior Parks, Open Space and Trails Plan proposes a trail along the north side of Highway 128 and east of McCaslin Boulevard. This trail would be directly across the highway from Rocky Flats' northeast corner (Superior 2001).

Coal Creek Canyon Park

The Management Plan for Jefferson County Open Space's Coal Creek Canyon Park describes the potential for soft-surface, multi-use trails on Jefferson County lands about 1 mile southwest of Rocky Flats. However, Jefferson County does not plan to develop any recreational facilities until uncertainties are resolved regarding neighboring land uses (JCOS 2001).

Air Quality

Rocky Flats is located within the boundary of the Denver Metropolitan Area for air quality planning purposes. For many years, the Denver metropolitan area has experienced carbon monoxide, ozone, and particulate matter air pollution as well as visibility problems. These conditions have recently improved, however, and the Denver area is now in attainment of all of EPA's health-based standards for air quality (EPA 2002). Regulatory requirements may control the timing of certain natural resources management activities, such as prescribed burning, which requires a permit from the State.

Air quality is monitored at five air monitoring stations operated by the Colorado Department of Public Health and Environment. Two of these stations are located just off-site at the northeast and southeast site boundary along Indiana Street, downwind of Rocky Flats. All criteria air pollutants are below state standards. It has not been determined whether the air monitoring stations will be removed following cleanup of the site.

Socioeconomics

Population and Demographics

The population in Jefferson County grew from 438,430 in 1990 to 527,056 in 2000 (U.S. Census Bureau 2002), an average annual increase of about 1.8 percent. Jefferson County population is

expected to increase about 0.75 percent annually from 2000 to 2015, while the state population is expected to increase by 1.7 percent annually (Colorado Department of Local Affairs 2002).

Rocky Flats is located in Jefferson County's North Plains Community Planning Area, which also includes portions of Westminster, Arvada, Golden, and unincorporated areas. Within this planning area, the population grew from 8,453 in 1990 to 10,194 in 2000, an average annual increase of about 2 percent (Jefferson County 2002). About 95 percent of the North Plains population consider themselves to be white (compared to 83 percent state wide), while about 5 percent consider themselves to be Hispanic or Latino in origin (Jefferson County 2002).

Employment

The average unemployment rate for Jefferson County in 2001 was 3 percent, while the state average was 3.72 percent (Colorado Department of Local Affairs 2002). In 2000, the services sector employed 79,317 workers while the retail trade sector employed 62,838, and the government sector employed 51,762 (Colorado Department of Local Affairs 2002).

Income

In 2000, per capita personal income was \$36,442, a 5.6 percent annual increase since 1990. Total personal income in Jefferson County was \$19.3 billion in 2000, up from about \$9.4 billion in 1990, reflecting an average annual growth rate of about 7.5 percent (Bureau of Economic Analysis 2002). The largest sources of work related personal earnings, by industry were services (16.1 percent), government (8.3 percent), and manufacturing (7.9 percent). Retail trade accounted for about 3 percent of the total personal income in 2000. Transfer payments, dividends, interest and rent accounted for 22 percent of personal income in 2000 (Bureau of Economic Analysis 2002).

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